

Application No.: 09/985,693

Docket No.: 21806-00143-US

REMARKS

Claims 26, 28, 30-32, 35-45, 50, 52-54, and 56-57 are now pending in this application. Claim 26 is independent. Claims 26, 30, 31, 35-37, 39, 40-45, 50, 52-54, 56, and 57 have been amended, claims 27, 29, 33, 34, 46-49, 51, and 55 have been canceled by this amendment. No claims have been added.

Comments on Previous Election of Species Requirement

Applicants have canceled non-elected species claims 33, 34, and 46-49 without prejudice or disclaimer, and reserve the right to timely file a divisional application to prosecute these species claims.

Anticipation Rejection over Nishiguchi

Withdrawal of the rejection of claims 26, 28-30, 32, 35, 36, 45, and 50-57 under 35 U.S.C. §102(b) as being anticipated by Nishiguchi (US 5,214,308) is requested.

Applicant notes that anticipation requires the disclosure, in a prior art reference, of each and every limitation as set forth in the claims.¹ There must be no difference between the claimed invention and reference disclosure for an anticipation rejection under 35 U.S.C. §102.² To properly anticipate a claim, the reference must teach every element of the claim.³ "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference".⁴ "The identical invention must be shown in as complete detail as is contained in the ...claim."⁵ In determining anticipation, no claim limitation may be ignored.⁶ The applied art fails to meet this threshold requirement, at least with respect to independent claim 26, as amended.

¹ *Titanium Metals Corp. v. Banner*, 227 USPQ 773 (Fed. Cir. 1985).

² *Scripps Clinic and Research Foundation v. Genentech, Inc.*, 18 USPQ2d 1001 (Fed. Cir. 1991).

³ See MPEP § 2131.

⁴ *Verdegaal Bros. v. Union Oil Co. of Calif.*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

⁵ *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

⁶ *Pac-Tex, Inc. v. Amerace Corp.*, 14 USPQ2d 187 (Fed. Cir. 1990).

Application No.: 09/985,693

Docket No.: 21806-00143-US

Background Discussion of Applicants' Disclosure

By way of background, the present application, in a one embodiment, is concerned with providing a method for joining two substrates in a semiconductor structure for "controlled collapse chip connection" (C4) interconnection of devices having self-aligning capabilities to ensure proper alignment of the two structures joined. The self-aligning aspects of Applicants' invention are brought about by using relatively "large" solder bumps to roughly, or initially align a plurality of C4 contacts between two substrates. Then, surface tension in wetted solder which is in contact with each of a plurality of C4 contacts is relied upon to finely align the tightly spaced C4 interconnects to a level, typically, within 10% of the solder bump diameter. The level of fine alignment of C4 interconnect achieved by Applicants' novel approach is submitted as not being achievable with conventional alignment techniques, such as are disclosed in the applied art, which rely upon physical force or external movement of the contacts to achieve alignment.

Consequently, within the arena of C4 technology, the present application achieves an order of magnitude or more improvement in the number of C4 interconnects which are now possible to be joined. For example, as discussed in the Specification, the conventional limit for C4 interconnection technology, which has a C4 connection diameter of about 50mm, on a pitch of about 100mm, is, at most, about 10,000 C4 interconnects. This results in a chip having an area of about 1cm². The structure and method of the present Application allows a much greater interconnect density, compared with current C4 technology, e.g., 100,000 interconnects per square centimeter, an order of magnitude or more increase, between the structures being joined.

For such an improved contact density, the contacts would have approximately, for example, a 15μm diameter, on a pitch of approximately 30μm. To achieve about 50% alignment of the C4 contacts, a 7.5μm alignment tolerance would be necessary from the initial alignment of the rough align solder bumps, i.e., the "larger" bumps. The large solder bumps have approximately a 10% alignment capability, allowing use of a solder bump having approximately a 75μm diameter, on a 150μm pitch. These limits on the large solder bumps are readily achievable with conventional component placement machines. The fine alignment achieved by the recited invention does not rely upon the machine placement accuracy, as long as the large

Application No.: 09/985,693

Docket No.: 21806-00143-US

solder bumps are placed within the above limits, for example. Surface tension acting on the C4 contacts is used to achieve the fine C4 interconnect alignment.

Discussion of Nishiguchi

In contrast, Nishiguchi et al. is directed to a substrate for packaging a semiconductor device having a relatively large bump, which is received by a recess having an electrode terminal therein. The particular point of novelty of Nishiguchi et al. appears to be the use of a recessed electrode terminal as shown in Figs. 2-3, rather than merely a flat electrode terminal. The recessed electrode terminal is used for "coarse" positioning by physically moving the device, e.g., with a component placement machine, and then more precise positioning is accomplished by "merely lightly pushing the semiconductor device to the packaging substrate after coarse positioning to assure that the tops of the higher bump electrodes do not swell out of the recesses formed in the higher electrode terminals, the bump electrodes on the semiconductor device can be highly precisely positioned to the electrode terminals on the packaging substrate."⁷

By using the approach of Nishiguchi et al., the precision requirement for a positioning machine used to place the components in position for packaging was relaxed from $\pm 10\mu\text{m}$ to $\pm 50\mu\text{m}$. With reference to Fig. 2 of Nishiguchi et al., a representative size of bump 2 formed on the semiconductor device 1 is indicated as being $80\mu\text{m}$ in diameter, while electrode terminal 5 on substrate 3 has a diameter of $100\mu\text{m}$.

Thus, it appears clear that, even if Nishiguchi et al. discloses a C4 interconnection structure which anticipates applicants' invention, not a clear proposition given the level of integration and density present in the present application, Nishiguchi et al., at best, represents the conventionally achievable C4 approaches which rely upon external, mechanical force to push the contacts into alignment. Such conventional approaches are submitted as being unable to provide an interconnection density as in the present application, as described in Applicants' background section of the Specification, and as discussed above.

⁷ See Nishiguchi et al., col. 1, line 63+.

Application No.: 09/985,693

Docket No.: 21806-00143-US

Nishiguchi discloses using a *tapered recess* in the substrate to roughly align the smaller contacts, not surface tension of the first solder bumps, and does not teach or suggest use of controlled-collapse chip connection ("C4") contacts, which may be defined as "[a] collapsed solder joint, between a substrate and a flip-chip, whose height is controlled by the surface tension of the liquid solder."⁸

Specific Deficiencies of Nishiguchi

The applied art does not disclose a method of fabricating a semiconductor structure which includes, among other features, "... providing a plurality of controlled collapse chip connection ("C4") solder bump contacts on one of the first substrate and the second substrate; providing first solder bumps on one of the first substrate and the second substrate, wherein the plurality of C4 solder bump contacts have a different solder composition than the first solder bumps. . . reflowing the first solder bumps at a first temperature to initially align the plurality of C4 contacts by a surface tension of the reflowed first solder bumps; and finely aligning the plurality of C4 contacts by reflowing the plurality of C4 contacts at a second temperature higher than the first temperature," as recited in independent claim 26, as amended.

Therefore, since the applied art does not disclose all the claimed limitations, consideration and allowance of independent claim 26 is requested. Further, since dependent claims 28, 30-32, 35-45, 50, 52-54, and 56-57 variously and ultimately depend from claim 26, these claims are submitted as being allowable at least on that basis, without recourse to the further patentable limitations contained therein.

Unpatentability Rejection over Nishiguchi and Love

Withdrawal of the rejection of claims 37-38 under 35 U.S.C. §103(a) as being unpatentable over Nishiguchi (US 5,214,308) in view of Love (US 5,773,889) is requested.

⁸ Electronic Packaging, Microelectronics and Interconnection Dictionary, Chas. A. Harper, and Martin B. Miller, McGraw-Hill, Inc., New York 1993, p. 44.

Application No.: 09/985,693

Docket No.: 21806-00143-US

At the outset, Applicant notes that, to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, *the prior art reference must teach or suggest all the claim limitations*.⁹ Further, the teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in applicant's disclosure.¹⁰

Even assuming that the references are properly combinable as suggested by the Examiner, Love does not make up for the previously identified deficiencies of Nishiguchi, as discussed above with respect to independent claim 26. Accordingly, reconsideration and allowance of claims 37-38 are requested.

Unpatentability Rejection over Nishiguchi

Withdrawal of the rejection of claims 39-44 under 35 U.S.C. §103(a) as being unpatentable over Nishiguchi (US 5,214,308) is requested. The legal requirements for unpatentability have been highlighted above.

The Examiner's assertion that contact diameter and pitch are "result-effective variables, and that it would have been an "obvious matter of design choice" is respectfully traversed.

Discussion of "Result-Effective Variables"

Similar to *In re Antonie*, 195 USPQ 6 (CCPA 1977) finding that a tank volume to contactor ratio was not a result-effective variable where the prior art did not recognize that wastewater treatment capacity was a function of that ratio, the applied art does not recognize achievement of high integration density, i.e., small C4 contact pitch and bump size, as being a

⁹ See MPEP §2143 (emphasis added).

¹⁰ *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991) and See MPEP §2143.

Application No.: 09/985,693

Docket No.: 21806-00143-US

function of solder surface tension of first solder bumps use to initially align a plurality of C4 solder bump contacts.

Accordingly, Applicants submit that the recited steps of independent claim 26, with the additional limitations of dependent claims 39-44 were not known at the time of the invention as concerning result-effective variables.

Discussion of "Design Choice"

The Examiner's assertion of "obvious design choice" appears to ignore the discussion of particular C4 contact spacing, provided above as background discussion, and as set forth in the Specification.

In similar circumstances relating to claims to an apparatus, "[t]he BPAI held that appellant had simply made an obvious design choice. However, the different structures of appellant and of the reference achieve different purposes."¹¹ Further, "[t]o require an applicant to include in his specification evidence and arguments regarding whether particular subject matter was a matter of 'design choice' would be tantamount to requiring the applicant to divine, before an application is filed, rejections the PTO will proffer. *A finding of 'obvious design choice' is precluded where claimed structure and the function it performs are different from those of the prior art.*"¹² (emphasis added).

Similarly, for the pending method claims, Applicants submit that a finding of "obvious design choice" should also be precluded when the applied art does not acknowledge the nature of the particular problem solved by Applicants' disclosed and claimed invention, i.e., achieving higher chip contact integration densities and reduced contact size and pitch with reliable contact alignment, as discussed above.

¹¹ *In re Gal*, 25 USPQ 2d 1076, 1078 (Fed. Cir. 1992).

¹² *In re Chu*, 36 USPQ 2d 1089, 1095 (Fed. Cir. 1995).

Application No.: 09/985,693

Docket No.: 21806-00143-US

Without the C4 contact methodology in Applicants' disclosure, Applicants submit that the applied art could not achieve the bump size and alignment necessary for the higher contact integration and reduced pitch.

Further, as stated in the MPEP and as held by the Federal Circuit, "[t]here are three possible sources for a motivation to combine references: the nature of the problem to be solved, the teachings of the prior art, and the knowledge of persons of ordinary skill in the art."¹³ Further with regard to the level of skill of practitioners in the art, there is nothing in the statutes or the case law which makes "that which is within the capabilities of one skilled in the art" synonymous with obviousness.¹⁴ The level of skill in the art cannot be relied upon to provide the suggestion to combine [or modify] references.¹⁵

Accordingly, reconsideration and allowance of claims 39-44 are requested.

Unpatentability Rejection over Nishiguchi and Kashiba

Withdrawal of the rejection of claims 27, 31, 37, 39, 40-44, and 53 under 35 U.S.C. §103(a) as being unpatentable over Nishiguchi (US 5,214,308) in view of Kashiba (JP 06-112463) is requested. The legal requirements for unpatentability have been highlighted above. Claim 27 has been canceled, thus rendering its rejection moot.

Even assuming that the references are properly combinable as suggested by the Examiner, Applicants submit that Kashiba does make up for the previously identified deficiencies of Nishiguchi, discussed above with respect to C4 contacts in independent claim 26, and does not teach or suggest the small bump size and smaller pitch achievable by use of C4 contacts, as variously claimed. Further, the assertion of "result-effective variable" and "obvious design choice" are traversed, as discussed above.

¹³ See MPEP §2143.01, citing *In re Rouffet*, 149 F.3d, 1350, 1357, 47 USPQ2d 1453, 1457-8 (Fed. Cir. 1998).

¹⁴ *Ex parte Gerlach and Woerner*, 212 USPQ 471 (PTO Bd. App. 1980).

¹⁵ See MPEP §2143.01, citing *Al-Site Corp. v. VSI Int'l Inc.*, 50 USPQ2d 1161 (Fed. Cir. 1999).

Application No.: 09/985,693

Docket No.: 21806-00143-US

Accordingly, reconsideration and allowance of claims 27, 31, 37, 39, 40-44, and 53 are requested.

Unpatentability Rejection over Nishiguchi, Kashiba, and Love

Withdrawal of the rejection of claim 38 under 35 U.S.C. §103(a) as being unpatentable over Nishiguchi (US 5,214,308) in view of Kashiba (JP 06-112463) and Love (US 5,773,889) is requested. The legal requirements for unpatentability have been highlighted above.

Even assuming that the references are properly combinable as suggested by the Examiner, Applicants submit that neither Kashiba nor Love make up for the previously identified deficiencies of Nishiguchi, discussed above with respect to C4 contacts in independent claim 26.

Accordingly, reconsideration and allowance of claim 38 are requested.

Anticipation Rejection over Kashiba

Withdrawal of the rejection of claims 26-32, 35-37, 39, 42, 45, and 50-57 under 35 U.S.C. §102(b) as being anticipated by Kashiba (JP 06-112463) is requested. The legal requirements for anticipation have been highlighted above. Claims 27, 29, 51, and 55 have been canceled, thus rendering their rejection moot.

The applied art does not disclose a method of fabricating a semiconductor structure which includes, among other features, "... providing a plurality of controlled collapse chip connection ("C4") solder bump contacts on one of the first substrate and the second substrate," as recited in independent claim 26, as amended.

Therefore, since the applied art does not disclose all the claimed limitations, consideration and allowance of independent claim 26 is requested. Further, since dependent claims 28, 30-32, 35-37, 39, 42, 45, 50, 52-54, and 56-57 variously and ultimately depend from claim 26, these claims are submitted as being allowable at least on that basis, without recourse to the further patentable limitations contained therein.

Application No.: 09/985,693

Docket No.: 21806-00143-US

Accordingly, reconsideration and allowance of claims 26, 28, 30-32, 35-37, 39, 42, 45, 50, 52-54, and 56-57 38 are requested.

Unpatentability Rejection over Kashiba and Love

Withdrawal of the rejection of claim 38 under 35 U.S.C. §103(a) as being unpatentable over Kashiba (JP 06-112463) in view of Love (US 5,773,889) is requested. The legal requirements for unpatentability have been highlighted above.

Even assuming that the references are properly combinable as suggested by the Examiner, Applicants submit that Love does not make up for the previously identified deficiencies of Kashiba, discussed above with respect to the anticipation rejection of independent claim 26 over Kashiba.

Accordingly, reconsideration and allowance of claim 38 are requested.

Unpatentability Rejection over Kashiba

Withdrawal of the rejection of claims 40, 41, 43, and 44 under 35 U.S.C. §103(a) as being unpatentable over Kashiba (JP 06-112463) is requested. The legal requirements for unpatentability have been highlighted above.

As discussed above, Kashiba does not teach or suggest all the limitations of independent claim 26, as discussed above, and therefore the assertions of "result-effective variable" and "obvious design choice" for these dependent claim features are submitted as not being germane.

Accordingly, reconsideration and allowance of claims 40, 41, 43, and 44 are requested.

Conclusion

In view of the above amendment, applicant believes claims 26, 28, 30-32, 35-45, 50, 52-54, and 56-57 pending in this application are in condition for allowance.

Application No.: 09/985,693

Docket No.: 21806-00143-US

Applicant believes no fee is due with this response. However, if a fee is due, please charge IBM's Deposit Account No. 09-0456, under Order No. 21806-00143-US from which the undersigned is authorized to draw.

Respectfully submitted,

By 

Larry J. Hume

Registration No.: 44,163

CONNOLLY BOVE LODGE & HUTZ LLP

1990 M Street, N.W., Suite 800

Washington, DC 20036-3425

(202) 331-7111

(202) 293-6229 (Fax)

Attorney for Applicant